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An automated procedure ten times more efficient in cutting labels for entomological collections

Ilia Gjonov[1]

1 *Sofia University, Faculty of Biology, 8, Dragan Tzankov blvd., Sofia, Bulgaria; gjonov@cicadina.com*

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Abstract. The labelling of entomological material is a labour-intensive and time-consuming task, often carried out by staff who are over-qualified for the task. This paper introduces a small automation step that speeds up this process via a method that uses a low-cost cutting plotter. The following text will present a financial and temporal analysis of the introduction and use of this equipment in labelling an entomological collection with any kind of labels.

Introduction

Entomological collections are distinguished from other biodiversity collections by their vast size, with a single entomologist's collection often including several hundred thousand specimens. A major challenge with these collections is the labelling of specimens, which is a laborious step. However, this is often treated as a peripheral activity of taxonomic work and is frequently neglected. Because of this, very large collections are often left with temporary labels pertaining to the collecting event. Sometimes, unlabelled specimens are just arranged in a row for which only the first specimen is labelled. Very often, the temporary labels contain only a number from a field notebook, and thus, all specimen information is at risk if the notebook is lost. It appears that many successful entomologists leave their collections unlabelled or partially labelled after terminating their employment, necessitating the hiring of staff to bring the collections into proper order. This should always be done with great care, as confusions of locality, date or other information contained on the label can lead to serious scientific errors. In addition to being a very responsible yet tedious activity, labelling entomological material is also very time consuming; depending on the workflow, it can take anywhere from about a minute to 3–5 minutes per specimen. In this situation, any possibility of saving time during labelling would be of high value to entomological collections.

For entomologists, the aesthetic appearance of specimen labels is important. The labels should be uniform and have standardized dimensions. Labels are usually printed on cardboard, which is then cut with scissors. The labels are framed either with a double border so that each label is evenly edged in black, or with very narrow borders so that the border on the label is almost invisible. In some cases, the labels are cut using a layout guillotine machine or paper trimmer, thereby avoiding the use of borders. In any case, the cutting has to be done very carefully, and therefore, it cannot be done quickly.

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Methods

The automation process proposed in this work uses a cutter plotter to cut the labels. The low-cost cutting plotter model used is the Silhouette Portrait 2 from Silhouette America, Inc. The actual cutting is done by a special "INKSCAPE-SILHOUETTE" v. 1.25 (Weigert 2021) extension of the open source vector graphics editor INKSCAPE v. 1.1 (Inkscape Project 2021). A sample label cutting vector template file is appended as a Suppl. material 1. After the labels are cut, they remain temporarily adhered to the adhesive plate (cutting mat) on which they are cut; they can then be peeled off using pincers or a spatula and placed on the correct backing. In our case, we generated the labels using the specialized collection management software SPECIFY v. 7.6 (Specify Collections Consortium 2021) by entering the information for each specimen collected during the day into the database so that creating the labels does not require additional time later. The generated 10 × 20 mm labels are printed on 160 g/m^2 A4-size cardboard (234–243 labels per sheet). The cardboard is glued onto specialized polymer sheets with a temporary adhesive available from the cutting tool's manufacturer. We found that the original plates sold with the cutting plotter could be replaced with almost any polymer (PE, PVC, PU, etc.) sheet of the appropriate size and thickness (0.3–0.5 mm), with lines drawn to position the sheet and with a temporary adhesive spray (often used to cut fabric) applied, which does not remain on the paper after it has been peeled from the polymer sheet. In this case, food-grade liners purchased from a household products store were used. The adhesive that we used successfully after the adhesive layer of the original cutting pads wore off, or for application on the cutting pads we adapted, was TAKTER 650 Adhesive Spray, manufactured by the Italian company Siliconi Commerciale SpA. Even better results were attained than for the adhesive on the original cutting pads because the labels peeled off more easily but still adhered to the sheet firmly enough to complete the cut.

Results

Within about a year, approximately about 42,000 labels have been cut, and an approximate cost per label by calculating the consumables and depreciation of the cutting plotter can be given, as well as the time required to cut the specimen labels (Table 1).

Table 1. Costs to use the cutting plotter for one year and to cut 42,000 labels. All prices are given for the Bulgarian market, with shipping (where applicable) and taxes included.

Cost	Price (€)	Pcs.	Amount (€)	Notes
Cutting plotter	222.00	1	222.00	The plotter is still working, but for valuation purposes, it is assumed to be fully depreciated.
Spear cutting knife	15.00	1	15.00	The original blade wears out after cutting about 30,000 labels.
Spray glue	6.00	2	12.00	
Original cutting mat	15.00	1	15.00	Bought with the plotter.
"Generic" cutting mats from Aliexpress	2.80	6	16.80	Bought from aliexpress.com. The price includes shipping.
"Home-made" cutting mats from a hardware store	0.80	4	3.20	Bought from a household products store.
250 sheets of paper, 160 g/m^2	9.00	1	9.00	
Total for 42.000 labels			293.00	Average price = 0.007 €/label

Figure 1. Cutting process.

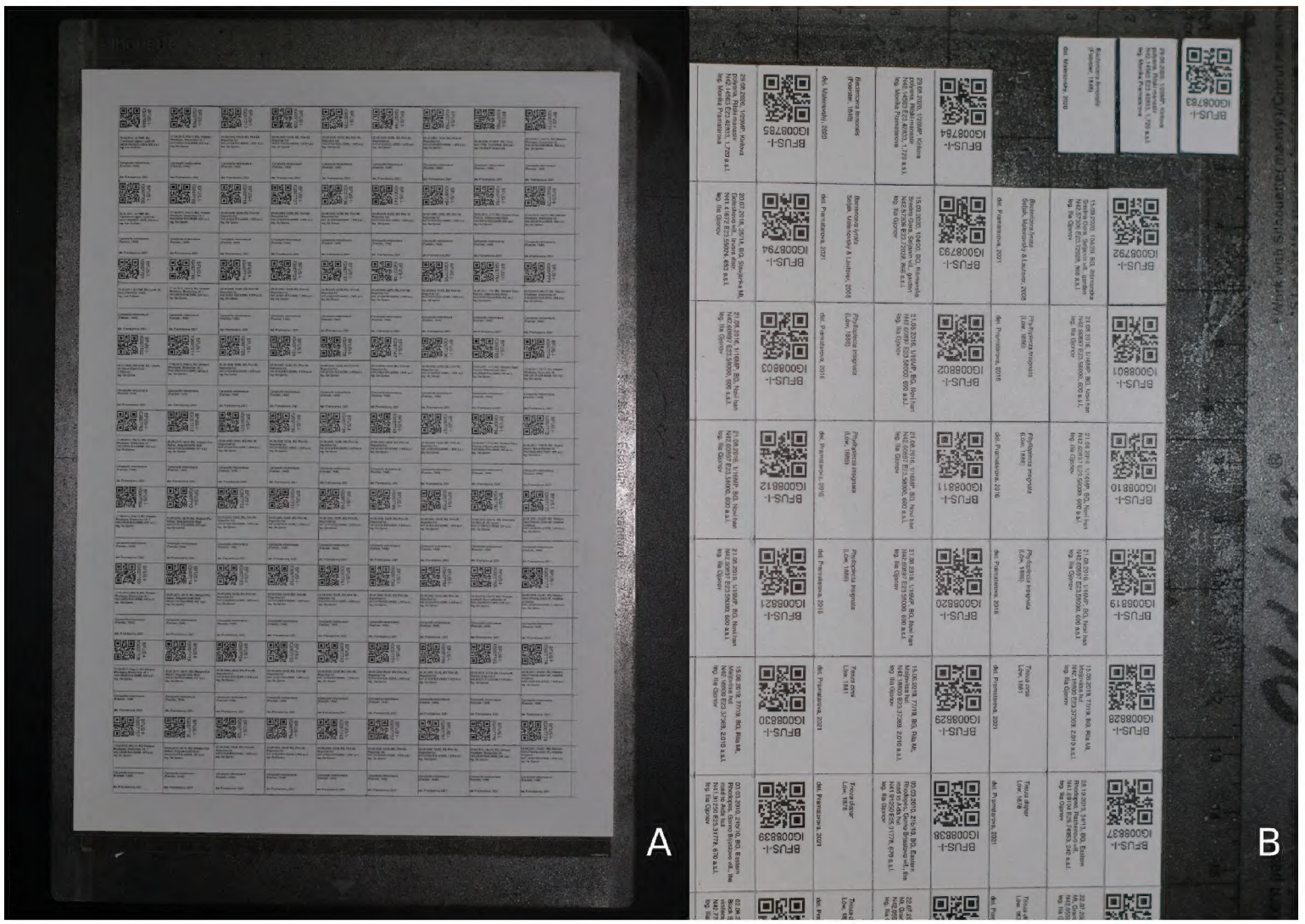

Figure 2. Labels cut. **A.** On the original cutting mat; **B.** On a "generic" cutting mat (part).

Figure 3. Part of an entomological box with specimens labelled using the presented method.

The approximate time to cut a single sheet with 234–243 labels was about 2–2.5 min, including positioning the sheet on the cutting mat and positioning the cutting plotter, which takes between 30 seconds and 1 minute; therefore, each label took 0.49–0.64 sec (Fig. 1). When cutting without the use of registration marks, a sufficient tolerance for the distance from the ideal cut line is about 0.5 mm. The cut marks remain temporarily adhered to the polymer sheet and can be easily peeled off with tweezers or a spatula so that they can be mounted on the pin with the specimen. This also ensures that the labels remain in the correct sequence, for example, in the same order in which they were generated. Labels cut on the original cutting mat purchased with the plotter are shown in Fig. 2A, while Fig. 2B shows labels cut on a "generic" cutting mat. The amount of time needed to peel the labels cannot be specified as it is related to the assembly of the labels on the objects of a collection.

In order to assess the impact of the automated approach described above, five colleagues were asked to cut a single sheet of 243 labels manually with scissors and the time it took each of them

Table 2. Measured times for manually cutting a single sheet of 243 labels using scissors, based on a test with five participants.

Test participant #	Cutting time for one sheet of 243 labels (minutes)	Cutting time per label (seconds)
1	42	10.4
2	33	8.1
3	25	6.2
4	21	5.2
5	16	4.0
Average time	27.4	6.8

to complete the task was measured. The results vary significantly: from 16 to 42 minutes per sheet (4 to 10.4 seconds per label) (Table 2). The average automated cutting time is therefore around 10 times less, compared to the manual cutting time.

With this method, we obtained evenly sized labels without any black borders remaining on the edges (Fig. 3).

Conclusion

We recommend the use of a cutting plotter to cut labels for entomological and similar collections, as it can alleviate the burden of simple tasks for a highly skilled personal. Label cutting can be further optimized by the use of registration marks, which most cutter plotter management software provides.

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Supplementary material 1

Template file

Authors: Ilia Gjonov

Data type: svg. file

Explanation note: A sample label cutting vector template file.

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